

AFFECTIVE DYNAMICS IN
RESPONSIVE MEDIA SPACES

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AFFECTIVE DYNAMICS IN
RESPONSIVE MEDIA SPACES

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SUMMARY

In this thesis computer-mediated human interaction and human computer interaction in responsive spaces are discussed. Can such spaces be designed to create an affective response from the players? What are the design heuristics for a space that allows for the establishment of affective dynamics? I research the user experience of players of existing spaces built by the Topological Media Lab. In addition to that I review other relevant experimental interfaces, e.g. works by Myron Krueger and my own earlier piece *Riviera* in order to analyze their affective dynamics. Also, I review the different applications and programming paradigms involved in authoring such spaces (e.g. Real-time systems like Max/MSP/Jitter and *EyeCôn*) and how to apply them in compliance with the design heuristics.

1 Introduction

The reason is, and by rights ought to be, slave to the emotions.

--Bertrand Russel

In our environment, we are entangled in a web of interactions with machines, which is getting tighter constantly. These machines, and especially the personal computer (and similar computational devices), which as a real embodiment of a Turing machine (Turing 1950) is able to calculate everything a machine is theoretically able to calculate, serve a wide range of ends. Their application does not stop at deeply human needs like communication with one's fellow humans.

The interaction with the machines of the age of information has become a daily routine for most people in the developed countries. The computer, once a niche product for mainly military use, has not always been seen as suitable for mass use, a view that is reflected by the predication of IBM chairman Thomas Watson, who stated in 1943: "I think there is a world market for maybe five Computers."¹ (Kurzweil 1999) After significant improvements in the user interface, a development that started when von Neumann decided to allocate numerically encoded instruction sequences to

¹ See also (Johnson 1997, 147), where he points out that Watson does not only refer to the current world market, but also makes a prognosis for the largest possible world market for computers.

the switches of the ENIAC and thus made the use of this computer easier through the invention of the machine language (Moravec 1988), the user base of the computer started to widen

From the beginning, computers were also used for performative and playful applications. In 1962 Martin Graetz, Stephen Russell et al. programmed what is seen as the first computer game : *Spacewar!* (Graetz 1981). Using an interface of a wooden box equipped with two levers and one button, the two players could control their spaceship on the screen and try to shoot the spaceship of the other player. To give the game an element independent of the players, a simple physics model that simulated gravity was introduced to the game. This resonates with modern day computer games, which are built on game engines that incorporate physical simulations and also with the pseudo-physics that are part of the TGarden media choreography engine² (Sha, MacIntyre et al. 2004).

After further improvements in the human computer interaction, pioneers like Ted Nelson, the author of *Computer Lib / Dream Machines* (Nelson 1970-1974), which is referred to as "the most important book in the history of new media" by (Wardrip-Fruin and Montfort 2003), saw that there is much more to the computer than calculating and improving productivity. He saw interactive systems of capable of creating an emotional response in the user. In his essay about dream machines he writes: "I have not mentioned the emotions. Movies and books, music and even architecture have for all of

² For more information about the TGarden media choreography engine , see also chapter 3 about Media Choreography

us been part of important emotional moments. The same is going to happen with the new media. To work at a highly responsive computer display screen, for instance, can be deeply exciting, like flying an airplane through a canyon, or talking to somebody brilliant.” (Nelson 1970-1974)

30 years after Nelson envisioned his dream machine, responsive systems are starting to fulfill some of his prophecies about emotions and the new media. Embodied play in rich media spaces opens up the possibilities of fulfilling interaction with other players and the system itself.

Informed by research into the possibilities of affect and emotion in responsive spaces I want to talk about the following questions:

- What are the affective dynamics of the responsive spaces discussed?
- What are the design heuristics for such spaces?
- What are the different programming paradigms that can be used to choreograph such a space.

Affect and emotion play an important role in human functioning. As Norman points out, “affect, emotion and cognition have also evolved to interact with and complement one another.” (Norman 2004) To function effectively in the rich and complex environment of the world cognition is needed to interpret the world, whereas affect is a system to make value judgments, to decide what’s good or bad, safe or dangerous (Norman 2004). In agreement with

Brian Massumi one can say that earth itself has always been the ultimate immersive environment (Massumi 2002), or the ultimate responsive space.

In this thesis, I survey the history and state of the art of the craft of responsive media spaces. I also discuss some theoretical critical writings relevant to affective dynamics in responsive media spaces. This thesis is descriptive and not making an argument. My thesis is written for peer practitioners making responsive media spaces.

1.1 Responsive Media Spaces

Responsive media spaces augment the theatrical mise-en-scene, which is traditionally composed of setting, costume, lighting and staging (see e.g. (Bordwell and Thompson 2001)), by computational technologies of performance. These technologies include sensing, e.g. video motion tracking or sensors worn on the body, sound and video which are generated in real time and media choreography software. The media choreography software is used to read and process the sensory input and to generate the response in form of real time video and sound.

Responsive spaces depend on the physical co-presence of living people in a common place. The people who inhabit a responsive space are called players in this thesis. In a responsive media space these players shape the media with the movement of their bodies. For example, they can pull out

sound of a field with a gesture or they can sculpt video with their hands³. The aim is to make digital media tangible and give it qualities like materiality, hapticity and tactility.

Another important aspect is the incorporation of bodily sensation in responsive spaces. They are a proximal environment for the players, in which they can feel their own presence and the presence of other players. The bodily sensations in responsive spaces include touching and being touched, like in *Regina*, which is centered around a seeker playing with the queen of a hive and enters into a new state when the seeker touches the queen.

Furthermore, responsive spaces are time based. The experience of the player has temporal dynamics. There is a dramatic development in responsive spaces over time. Like in theatre, the mise-en-scene can change in order to support the dramatic development, only in responsive spaces this also involves changes in the computational components of the mis-en-scene. For example, the projected video can change, like in *Regina*, where quiet water changes to stormy, or the response of the space to certain actions of the player can change after a certain event, like in *Riviera*, where different stages or levels provide different possibilities for interaction. The quality of the response can change.

³ for specific examples of how players can manipulate media in responsive spaces, refer to the description of spaces like *Regina* or the *Membrane* in the respective chapters.

There are two types of responsive spaces, the ones that have a fixed time (like *Riviera*, which is discussed later in this thesis) and the ones that are open ended (like *Regina* and the *Membrane*, also discussed in the respective chapters). Spaces with a fixed time start at a certain point in time and end after a certain amount of time has passed, similar to a movie or to a theatrical performance. When a player enters such a space she knows that the space has begun at exactly this moment, nothing has happened before in the space. When the set time ends and the player leaves the space, the dynamical development of the space is over and all the parameters are set to their initial values. In an open ended space, the player can enter at any given time, without having to wait for a certain starting time. The space exists and evolves also before a specific player enters the room. Other players can already be in the space when a player enters, creating a situation where players that are more familiar with the space inhabit it together with less experienced players. An open ended space does not end after a fixed amount of time.

Responsive media spaces are different from artificial and virtual reality since the players don't have to wear any type of head mounted display. The engagement with the space is not reduced to a purely visual experience. The media is in the space where it can be seen, heard and touched by all the players in order to create a real time shared experience. Also, a head mounted display doesn't have a theatrical meaning, which makes it difficult if not impossible to integrate it into a scene without breaking the metaphor. Responsive spaces are also different from computer games, since they are

centered around free form play and are not goal-oriented, whereas most computer games involve rule based, goal oriented puzzle solving.

In responsive spaces, there is no separation between an active actor or performer and a passive spectator or audience, like it is the case in theater, film and in interactive performances like *Riviera*. The spectator becomes the player and actively interacts with the other players and the responsive space he inhabits.

1.2 Affective Dynamics

Responsive media spaces are inhabited by bodies in states of movement and rest. Due to the temporal dynamics of the responsive space, these states change continuously. In his book *Parables for the Virtual* (Massumi 2002), Brian Massumi develops a theory for the relationship of movement and affect. He points out that "Spinoza defined the body in terms of relations of movement and rest", saying that Spinoza "was referring to a body's capacity to enter into relations of movement and rest." He goes on to state that Spinoza spoke of this capacity "as a power (or potential) to affect or to be affected. As Massumi puts it, "the Spinozist problematic of affect offers a way of weaving together concepts of movement, tendency, and intensity" (Massumi 2002). The fact that movement and affect are intrinsically linked provides the foundation for understanding affective dynamics in responsive media spaces. The sensation that the players feel as they move through the

space is caused by the variation in their bodily intensity, the intensity which is equated with affect by Massumi. I speak of affective dynamics to emphasize the transitional nature of affect and movement in responsive spaces. The state of the players changes continuously between different intensities of movement and rest, which leads to a change in affect.

2 Experimental Interfaces

In this chapter, I present an overview of work with experimental interfaces, interactivity and responsive spaces. Starting with Myron Kruger, who pioneered augmented reality and interactive media installations, and finishing with a discussion of my own works *Riviera* and *Regina*, I will show different approaches and possibilities in the field.

The work with the new media and the exploration of the new possibilities that are connected with them is a domain where the arts and the sciences meet, either in the form of a collaboration between artists and scientists or in one person with an interest in both of the two cultures (Snow 2000) like Myron Krueger, who was educated as a computer scientist and pioneered the field of responsive environments. Despite the dramatic rift between the arts and the humanities on one side and the sciences on the other side, which as C.P. Snow analyses in his book „*The Two Cultures*“ (Snow 2000), is deepened by the growing specialization in the respective scientific and

humanistic disciplines, there is a growing number of artists who are approaching the field of digital technologies and the possibilities of interactivity that come with it.

The use of the latest technology in artistic work is a phenomenon which could also be seen in earlier eras. In the Renaissance, a lot of inventions became available on the media market place, which similarly to today's computer technology were originally developed in the military domain. Etching was used in the production of arms before it was used as a form of artistic expression and copper engraving did not only change the sphere of production but also the sphere of distribution. Ideas were distributed in all of Europe and lead to a homogenization of style (Wyss 1997). With the further development of new technologies their influence on art and the artist can also be seen in the following centuries, either through their incorporation into the artwork or through their ability to guide artistic expression into new directions.

In his essay „Das Kunstwerk im Zeitalter seiner technischen Reproduzierbarkeit“⁴ (Benjamin 1969) which was written in 1935 Benjamin writes that changes in the technological conditions can change the collective consciousness and cause important changes in cultural development. He emphasizes this position with a quote by Paul Valery, which he placed at the beginning of his essay:

⁴ Engl.: "The Work of Art in the Age of Mechanical Reproduction"

„Neither matter nor space nor time are what they have been 20 years ago. We have to become ready to see that great inventions will change the entire technology of art, by which they will influence the invention itself and finally perhaps change the notion of art in the most magical way.“⁵ (Benjamin 1969)

One of the artists that has set out to change the notion of art in the most magical way with his responsive environments, which were fusing art with computer science and technology, will be discussed in the next chapter.

2.1 Myron Krueger

Educated as a computer scientist his work focused on the development of computer controlled responsive environments. In his work *Videoplace* the interactor's image is the device through which the artificial reality is explored. The user is filmed and his image is projected on to a screen, where he can interact with projected computer generated objects and images of other users. David Rokeby sees the transformation of the user as the connecting element between his and Krueger's work. The interactivity, which is the foundation of both systems, always causes a change in the self-representation of the interactors (Rokeby 1995).

⁵ translated by the author

Long before Rokeby carried out his experiments in between art and technology, Myron Krueger was beginning to explore the possibilities of responsive environments. Krueger was one of the first persons who dealt with the artistic implications of responsive media spaces. His pioneering work in this area earned him respect in the fields of art and technology alike. Jaron Lanier, a leading expert in the field of virtual reality, for example, introduced him at SIGGRAPH saying: "This is Myron Krueger, who is a wonderful pioneer. I've been influenced by him, I respect him enormously, and I appreciate him incredibly." (Woolley 1992) Winning a Golden Nica from the jury of the Prix Ars Electronica in 1990 for his work *Videoplace* in the category interactive art shows the recognition that his work has achieved.

This has not always been the case. Contrary to contemporary designers of responsive spaces like the Topological Media Lab, Krueger could not rely on readily available and reasonably priced software and hardware for his work. When he applied for a grant from DARPA in 1974 to develop a global space for communication based on his system *Videoplace* he was turned down. The attitude towards work with responsive environments at this time can also be judged by the fact that his dissertation „Computer Controlled Responsive Environments“, which he wrote in the mid-seventies could only be published in 1983 (Woolley 1992).

Krueger's first work, *Glowflow*, was created in 1969. *Glowflow*, which he calls a „kinetic environmental structure“ (Woolley 1992), consists of pressure sensitive sensors on the floor which trigger sequences of sound and

light when being touched. The space was ascribed moods, affective states and even emotions by the players, which were triggered by their movement (Woolley 1992). This also led to interaction between the individual players. Strangers spontaneously started to form groups, they were playing, clapping and talking to each other (Woolley 1992). As (Dinkla 1997) mentions, the behavior of the visitors was determined by their urge to see through and understand the regulating system behind *Glowflow*. The reason for creating this work and also his later works is described by Krueger as follows:

„As I observed how artists related to their traditional tools, I noticed what they were doing with computers in the late 1960s. I found that they were trying to create art in time-honored formats. This seemed wrong. If the computer was to revolutionize the arts, it would define new art forms that would be impossible without it, not simply assist in the creation of traditional work.“⁶

In his next work, *Metaplay*, which he created in 1970, Krueger refined his idea of a rule-based artwork. The visitor is filmed by a video camera and her image is projected at a wall of the room. The image is overlaid with line drawings, which the artist is drawing using a digitizer tablet. The drawings change according to the actions of the visitor (Woolley 1992). Together with a cameraman, who picks the person to be recorded, Krueger is able to pro-

⁶ <http://www.aec.at/prix/kunstler/Emkrueger.html>

voke reactions from this person through his drawings or written words (Dinkla 1997).

In *Psychic Space* Krueger abandoned the video camera and decided not to use any kind of personal real time intervention. The interaction should be automated as far as possible. On the floor of the space he placed 384 pressure sensitive sensors. When the player moves over the fields, a rhombus moves on a projection surface, so that the player can realize it as a graphical representation of herself. The rhombus can be controlled by moving through a labyrinth. Breaking the rules of the space is being punished immediately. If for example the player crosses a border, the symbol breaks apart. On the other hand, blindly following the rules also does not lead to success. Shortly before the player reaches the goal, the labyrinth can suddenly move or the movements of the player can be interpreted differently. Thus, the goal cannot be reached even though it seemed so close. This strategy puts the interaction in contrast to most computer games, where following the rules leads to the goal (Dinkla 1997).

In his next work *Videoplace* the players are brightly lit and filmed with a video camera. The lighting is important because of the contrast. The image is analyzed by a series of specialized computers that were built by Krueger himself. The shadow of each player is projected onto a surface. Each of the participants, who were called *shadowpeople* by Krueger, can interact with objects, which are projected by the system. In some of the interactions Krueger also integrated a digital synthesizer, which was controlled by a

separate computer. The synthesizer creates sound based on the movements of the players (Dinkla 1997).

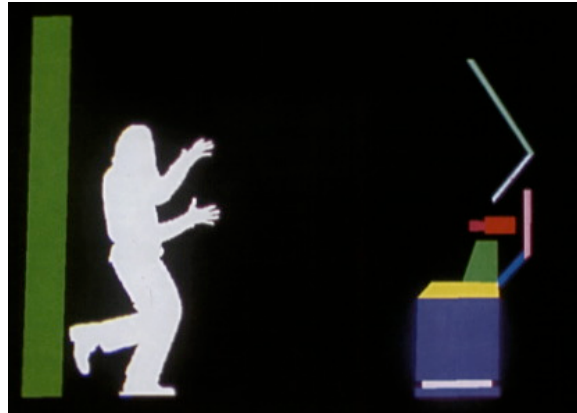


Figure 1: Videoplace – The shadow of the visitor and the objects he can interact with.⁷

Fundamentally there are two variations of *Videoplace*. In the first version, a new interaction is selected whenever a new person enters the space, the actions are called in sequence.⁸ Part of this version is *Individual Medley*, where the player structures the forms on the projection surface with his movements in the environment (Dinkla 1997). At places where the silhouettes overlap the colors change and seem to pulse. The shadow images can also be projected in a way so that they seem to be stacked in the image space over time to create a collage of movement phases.

In the other version a dialog between two players is created. The more experienced player takes her place behind the *Videodesk*, which works in

⁷http://www.aec.at/en/archives/prix_archive/prix_projekt.asp?iProjectID=2473

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⁸http://www.aec.at/en/archives/prix_archive/prix_projekt.asp?iProjectID=2473

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analogy to the *Videoplace*. From there she can interact with the other player by using a projected image of her hands and also select the form of interaction.⁹

With his *Videoplace* system Krueger is addressing an audience that is not necessarily educated in art history or computer technology, which makes it essential that there is no need for specialized knowledge to use his system. This approach can be explained by his background as computer scientist, who deals with the subject of human-computer interaction in an artistic way and wants to enable a broad audience to interact with his system. Instead of hiding behind artistic or technological codes he chooses the approach of intuitive understanding without particular prerequisites for the player.

Krueger's focus was also on the sensations of the players in *Videoplace* and he also discusses the affective dynamics. He points out that the proprietary feeling that each person has towards his own image determines the impact of the experience. There is a strong connection between the player and his representation. Krueger goes so far to say that "when one person's image overlaps another's there is a psychological sensation akin to touch." (Krueger 1977) Krueger has provided a space for mesoperception¹⁰, for synesthetic sensibility. Vision folds into touch. As (Massumi 2002) puts it,

⁹ http://www.aec.at/en/archives/prix_archive/prix_projekt.asp?iProjectID=2473
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¹⁰ for a discussion of proprioception, see the chapter about Affect Design

"Crosssense referencing forms a third hinge-dimension of experience. This "lost" dimension of experience is where vision's conscious forms-in-configuration feed back into the vectorial tendency-plus-habit of proprioception, and where proprioception feeds into vision. Where we go to find ourselves when we are lost is where the senses fold into and out of each. We always find ourselves in this fold of experience."
(Massumi, 182)

Krueger uses the term *artificial reality* for his interactive environments. He does not see this term as a solely technological label, but wants it to be understood in a broader sense. It should explain the paradigm change which is caused by the reality that man is not anymore at the mercy of the forces of nature but has created his own new world with technological means: *artificial reality* (Woolley 1992).

David Rokeby analyses the common affective dynamics of Krueger's *Videoplace* and his own *Very Nervous System* by stating that:

"In many of Krueger's Videoplace interactions the interactor's image is the device through which the 'artificial reality' is explored. The transformations of this silhouette are the keys to the understanding of the world depicted on the video screen. The self-image is the known reference against which the phenomena of transformation are registered. In my own work Very Nervous System, a computer looks out through a video camera, and gathers a sense of the physical gestures of the interactors. These impressions are immediately translated into sounds or music, reflecting and accompanying the gestures, thereby transforming the interactor's awareness of his or her body. In both cases, the character of the experienced phenomenon is discovered as a change in a representation of the self (Rokeby 1995)."

His observation resonates with Brian Massumi's idea of Mesoperception (sensation), which is the synesthetic sensibility. Massumi points to that "it is the medium where the inputs from all five senses meet, across subsensate excitation, and become flesh together, tense and quivering. Mesoperceptive flesh functions as corporeal transformer where one sense shades into another over the failure of each, their input transformed into movement and affect. (Massumi 2002) "

2.2 The Membrane

The *Membrane* is an example of free form play, involving one, two or more users. This installation was created in 2003 and demonstrated at Ubi-comp2003 in Seattle (Sha, Serita et al. 2003). The question raised for this demonstration was how a socially playful ambience could be induced in a dead space like a conference hotel lobby. The *Membrane* consists of a translucent ribbon, which is suspended on metal tubes. Live video is projected on the fabric to transform it into a magic membrane. The membrane is suspended in public space so that people can walk on either side of it. Transformations, smoothly varying in time and space, of people on the other side of the membrane can be seen by the players. The effects are driven by the movement of the players on either side.



Figure 2: Two players tracked in video, tugging at spring, projected onto common fabric. (Sha, Serita et al. 2003)

In addition to remain legibly and interesting over the characteristic time that a passerby is likely to be near the membrane, the goal of the membrane is to provide the affordances for affective dynamics that induce play and not puzzle solving behavior. The dynamic effects of the membrane are ideally tuned in a way that allows for the establishment of affective bonds between the players on each side. For a limited amount of time, strangers

can engage in free form play and interact with the video projected on the membrane and mediated by the membrane with each other. Similarly to Myron Krueger's work, the membrane can create a place where strangers can safely play with each other. It draws people on the opposite sides to one another. As stated in (Sha, Serita et al. 2003), "The same effects that transform the other person's image should also make people feel some of the safety of a playful mask. The goal is to allow people to gently and playfully transform their view of the other in a common space with partially re-synthesized graphics."

Like wearing masks, the membrane creates the same sense of polyvalence in the relationship with the other. When playing with the membrane, the pleasure is derived from the fact that there is a transformation in what and how we see ourselves and the other player. By having this transformative effect, the membrane does not only stand in the same line as the *Very Nervous System* and Myron Krueger's work, but is also in the tradition of the *Holy Theater*, as envisioned by Jerzy Grotowski (Brook 1996). The *Holy Theater* is "that which is utterly transformative and as inescapable and implacable in its effect on the spectator as the plague." (Sha 2004) Grotowsky's theatre is "a vehicle, a means for self-study, for self-exploration,; a possibility of salvation." (Brook 1996). Whereas Grotowsky's theatre still separates the actor and the spectator, the responsive space the *Membrane* lets the player do the work of the actor.

2.3 Regina

Regina is a responsive media space that was created by Yvonne Caravia and Wolfgang Reitberger with the support of other members of the TML¹¹ in 2003. The creation of this space was loosely based on the idea of an ant- or beehive, in which La Regina, the queen, lives. Visitors to this space can meet La Regina, will be greeted by her and can interact with her in various ways. In addition to that, we wanted to explore the possibility of giving the players and La Regina magic or even god-like powers, represented by the control over the surrounding elements. The players are able to influence that state of water. They can change its properties from peaceful and quiet to stormy and bubbling wild water.

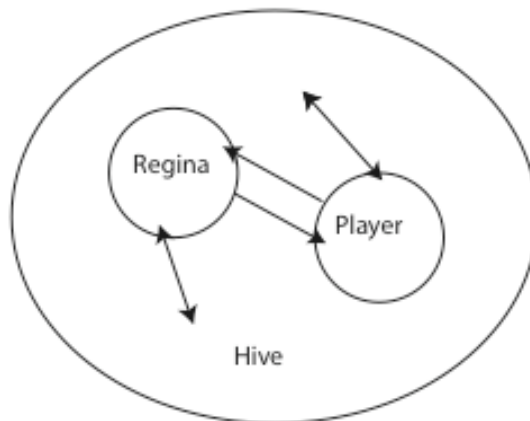


Figure 3: Interaction schema for *Regina*, arrows indicate interaction between entities

¹¹ Sha Xin Wei (Max/MSP programming, audio, sound), Yoichiro Serita (Jitter programming), Nina Walia (Max/MSP, audio, sound) and Julien Fistre (signal processing and analysis)

La Regina wears a TinyOS MICA mote, which is a wireless computer that is integrated in her costume. The mica wirelessly transmits the data it gathers from the sensors that are connected to it to a base station, which is connected to a computer running Max/MSP/Jitter. This computer analyzes the packets that are received via the serial port and transmits them via OSC (open sound control) to the other computers that are used for real time audio and video synthesis. She also wears a TinyOS mote around her leg, which gathers and transmits a stream of accelerometer data used for step detection. The seeker wears a magnet (or a flashlight) and a mica. The magnet is being sensed by the magnetometer which Regina is wearing, in order to know about the proximity of the seeker. As he approaches her, whispering sounds are multiplied and voices begin to grow in polyphony. When the seeker touches La Regina, there is a state change. New voices are added and the bend sensors are turned on, which enable Regina to modulate sound by gesture.

The video, which is projected on multiple layers of fabric that are suspended from the ceiling, is synthesized in real time on a computer running Jitter. The video is generated depending on the state of the room and of Regina. La Regina has the power to control the elements, she can change the water from quite and calm to continuously morph into a maelstrom with bubbles and waves on the surface. The intensity of the generated video, represented as hue and saturation, is changing dependent on the activity in the room. The activity is measured by adding up step detection data from the accelerometer using leaky accumulation. In addition to constantly adding up num-

bers, the leaky accumulator is also subtracting a set amount, so that the state of the room goes back to its initial state over time.

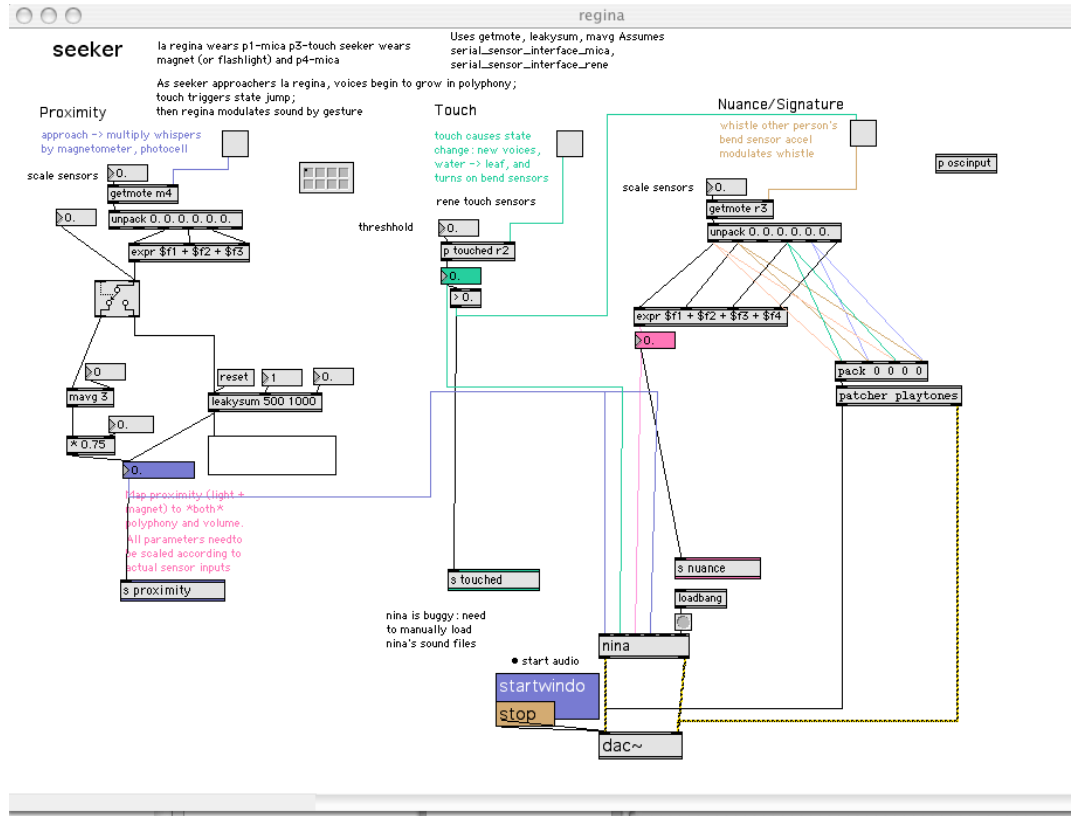


Figure 4: One of the Max patches that make up *Regina*. In this particular patch the interactions and responses on the audio level are defined. They are divided into the categories proximity, touch and nuance/signature.

The video is generated in a Jitter patch that allows cross blending between four or more sources of video in real time. The video clips are loops of water in different states, which have been edited and color corrected to seamlessly blend into each other as Regina changes the state of the water. The video patch allows continuous morphing of the video clips based on the parameters calculated from the sensor data.

The affective dynamics of La Regina can be characterized by looking at agency and transformation in this responsive space. The transformation occurs by taking the player and La Regina to a magical place, in this case a hive, where both of them are transformed, one of them into the queen of the hive and the other one into a seeker. Pleasure is derived not only from exploring the possibilities of the agency that the players have by trying to influence the sound and change the state of the water but also by exploring the dynamics of the relationship with the other player. La Regina provides a safe space to playfully engage in nonverbal interaction with another participant. As in some of Krueger's environments, La Regina leads strangers to play a different role and experiment with a way of communication that is based on real time shared experience.

2.4 Riviera

*„...we need to be more concerned with the role of art as it affects all of us. Art has, of course, always been humanity's highest form of the expression of freedom and imagination. But at the same time, art might have well started, as Jacob Bronowski suggested, as a tool of human survival.“*¹²

--Itsuo Sakane

To focus on the transformation of the user of interactive systems was one of the goals of the interactive performance *Riviera*¹³, which I created in collaboration with the performance artist Georg Hobmeier in 2000. The other goal was to create an interface, which would combine the expressiveness of the body with the possibilities of digital technology, an interface between the world of theatre and digital media. Because of its fragility the interface might be the location where the creative process is amplified or even originates to become part of the feedback loop between the human and the machine (Gsöllpointner and Hentschläger 1999).

¹² Sommerer/Mignonneau, 1998, p. 9

¹³ Additional information about *Riviera* and information about other works of the group *senselabor*, which was founded at the production of *Riviera* can be found at <http://www.senselabor.com/>

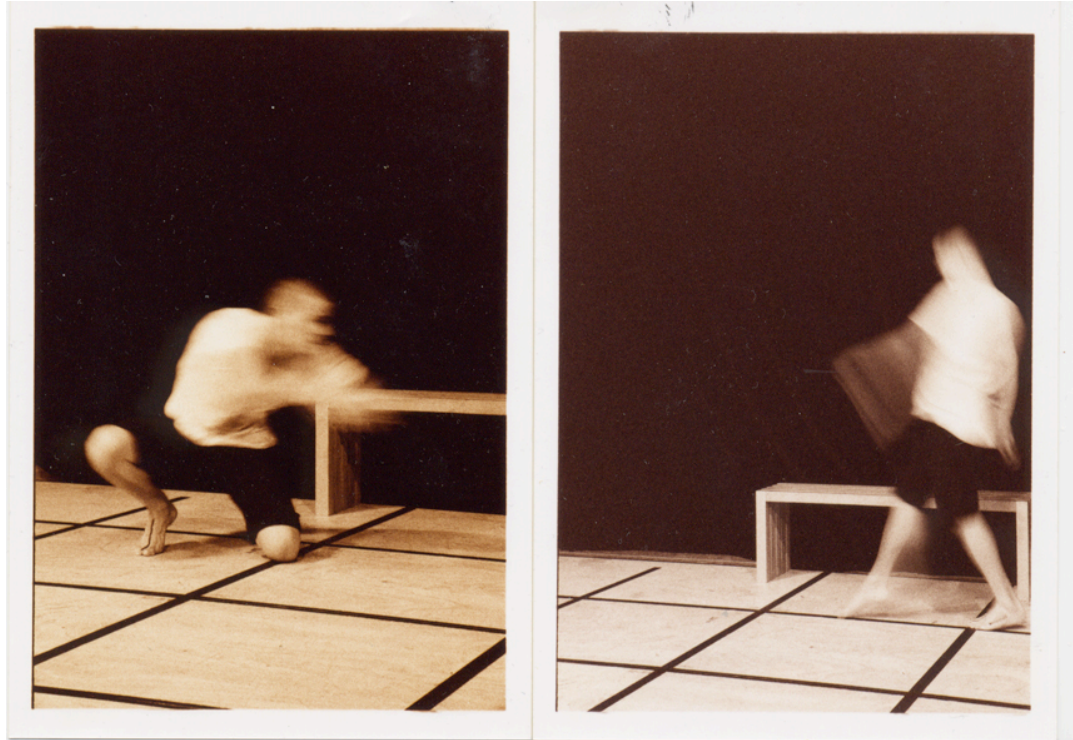


Figure 5: Still image from *Riviera*. The performer is seen in motion, manipulating the sound with his movement and gestures. The only prop used for most of the scenes is the bench seen in the background.

To create this kind of interface we used *EyeCôn*¹⁴, a camera based motion-tracking system. With this system, the movements of the user are filmed with a digital camera, which is connected to a regular PC, where the video signal is analyzed and where the reactions to this signal are defined.

When we created *Riviera*, we wanted to explore the possibilities of using an interactive system in a theatrical context. We also wanted to focus on the affective dynamics which would take place during the work on this interactive performance. The actor should not be controlled by a fixed set of rules

¹⁴ <http://www.palindrome.de>

which is imposed on him from the outside, from the text, the dramaturgy and the direction. He should be able to move in a space which is defined by a framework of possible interactions which are programmed into the system. On the one hand he would be governed by this framework, on the other hand he would be able to freely explore the structure of the overlapping virtual/imaginary and real space. The rules which are imposed on the stage by the interactive system are both, limitations of the possible and a door to new possibilities, which can be very numerous based on the number and complexity of the rules.

Riviera should not be technology for technologies sake, but should demonstrate how interactive technology can be integrated into an artistic process to develop scenes and situations which can be expressed by the play of the performer.

In the scenes we created for *Riviera*, we put the body in varying relations to the sound and tried to use the music in different ways: as gestural sound to enhance the dynamic of a gesture or a movement; as object sound to describe an item, a substance or a specific location; as counterpoint, contradicting what was currently happening otherwise on stage.

The first scene, called *Bank*¹⁵, was our first experiment using *EyeCôn*, to transform the room into an instrument. The performer enters the scene and

¹⁵ the bench

sits down on a centrally located bench. Through his movement he activates a ring of *touchlines*¹⁶, which surround his body and quiet noises start playing in the background. After sitting still for a while he discovers something next to his left leg. When he touches it and it makes a sound, he immediately moves back in shock. After that his curiosity wins and he begins to touch the invisible sound particle and starts to grasp it. He discovers more sounds and starts to add the sounds to create a song.

The next scene, *Handke*, starts directly after *Bank*. The performer has to read out sheets of paper which are scattered on the floor. Each of these sheets of paper is assigned the same text by the software, which can be played back with varying speed and pitch. The playback is activated by touching or picking up a particular piece of paper. The text is from Peter Handke's piece *Kaspar* : "Es ist unwahr, dass die Darstellung der Verhältnisse die einzig mögliche Darstellung der Verhältnisse ist: wahr ist vielmehr, dass es im Gegenteil noch andere Möglichkeiten der Darstellung der Verhältnisse gibt."¹⁷ (Handke 1968)" The speed of the text determines the speed of the movement. Different layers are condensed, then resolved and merged again. Through his selection of different pieces of paper (and the different samples that are attached to them) the performer sets his own speed. In this scene we worked with remixing techniques of previously existing speech samples and looked at their relation to embodied

¹⁶ see the chapter about *EyeCôn* for a detailed description of *touchlines*.

¹⁷ Translation by the author : "It is not true that the representation of the circumstances is the only possible representation of the circumstances: in fact it is true that on the contrary there are other possibilities for the representation of the circumstances."

expression. We created a situation where the imaginary text is made real through the movements of the performer.

The affective dynamics of both scenes can be defined by their capacity to let the performer bridge the virtual and the actual. Imaginary sounds and texts are brought into the analog actual. (Massumi 2002) describes this relationship saying that "a future directly virtual digitality will be multiplying and intensifying its relays into and out of the analog. The analog is not obsolete. The analog and the digital must be thought together asymmetrically. Because the analog is always a fold ahead."

3 Media Choreography

3.1 Design Heuristics

A space can only be made into a place by its occupants. The best that the designer can do is put the tools into their hands.

--Harrison and Dourish

Writing about affective dynamics brings up the question about the criteria, which can be used to evaluate responsive spaces. I want to propose a set of criteria that a system which can generate affective dynamics has to fulfill.

What are the design heuristics for a responsive space that does not only aim to invoke an emotional response from the players but also supports the creation of affective bonds between the users? How can we design a responsive space that gives the player a continuous experience which provides the affordances for flow, similar to skiing, swimming or playing a musical instrument? How can we implement the possibility for the user to acquire mastery of the space, like one learns to ski? Is there the same feeling of “flow” (Csikszentmihaly 1991) that one gets when playing an instrument for an extended time.

3.1.1 Gaps and cracks

Like a good movie, a well designed responsive space should not strive to control its effect on the player. There should be no manipulation of the user, no forced creation of affect and emotions in the user by means of using stereotypical and clichéd elements and clues. The responsive space should not resemble a ride at Disney World that includes artificially induced, “engineered” emotions, or employ the strategies used by soap opera directors. On a recent excursion to Walt Disney World, I had the chance to analyze some of the mechanisms used to induce certain affective responses in the visitors. These mechanisms consist mostly of visual and auditory effects that are strongly connotated with specific feelings for most viewers. For example, skulls and pirates suddenly appearing out of the darkness create a fearful reaction in the viewers, whereas singing parrots are greeted with a

cheerful response. The cultural symbolism of the media elements used by the imagineers is so strong that it feels almost totalitarian in its power to induce the "right" emotions. The possibility of having an experience that is different from everyone else's experience, to escape from the prison of canned emotions is a very remote one, if it exists at all. Resistance is futile.

On the contrary, a responsive space should only present a framework with enough room for the player to explore and to create his own experience. Film directors like Federico Fellini or Ingmar Bergman have made movies that, despite the constraints of a linear and scripted medium, leave enough ambiguity for the viewer. There are gaps that the viewer can fill with his own creativity and imagination. Responsive spaces that are designed for affective dynamics should also have these gaps and cracks. These cracks in the system give the player more freedom from the constraints generated by the designer.

When designing a responsive space, there is a very fine line between creating an immersive environment which the player can explore freely and creating what Kittler calls an "inscrutable simulation"¹⁸, in which the user would be entangled. According to (Kittler 1993), such a simulation increases the distance between the user and the hardware and condemns the human to remain a human. The media choreography¹⁹ (Sha 2004) for a system that

¹⁸ Undurchschabare Simulation

¹⁹ see also Sha, X. W., B. MacIntyre, et al. (2004). "Choreographing Responsive Media Environments Using Continuous State Dynamics on a Simplicial Complex." in preparation.

allows the possibility of a transformation of the player has to take this critique seriously.

In his critique of what he might call inscrutable space Kittler uses the language of vision, when he fears that the user cannot see through the simulation anymore. He reduces the interaction with the interactive system to an exchange of information. His analysis is solely based on informatics. Also, if one would consequently follow Kittler's idea of transparency, it is not clear when to actually stop. Is it the at the point where the machine language or at least the assembly language level is visible, which is the point where Kittler somewhat arbitrarily draws the line, or wouldn't one have to go even further, ending somewhere in the world of atoms or subatomic particles.

Informed by Gendlin's (Gendlin 1997) notion of felt meaning, transparency can be seen as something that is not only based on vision, on always being able to see through to the level of machine code in every computer system, like Kittler advocates, but also as having something to do with manipulability. In my opinion a system can be "transparent" to the player if she is able to easily manipulate it according to her intentions, even if the inner workings of the system are hidden.

3.1.2 Boredom vs. Anxiety – Flow and Responsive Spaces

Mihaly Csikszentmihaly describes the characteristics of a flow experience. The approach Csikszentmihaly uses is what he calls "a phenomenological

model of consciousness based on information theory.” (Csikszentmihaly 1991) He says it is phenomenological because it deals directly with events as we experience and interpret them instead of focusing on the anatomical structures or neurochemical processes. In contrast to what he refers to as “pure phenomenology”, his model also adopts principles from information theory (Csikszentmihaly 1991).

He states that every flow activity provides a sense of discovery, a creative feeling of transporting the person into a new reality. It pushes the person to higher levels of performance and leads to previously undreamed-of states of consciousness. These states include a change in the point of view, transformation of causality, time or texture and synesthesia. It transforms the self by making it more complex. He points out that the key to flow activities lies in this growth of the self.

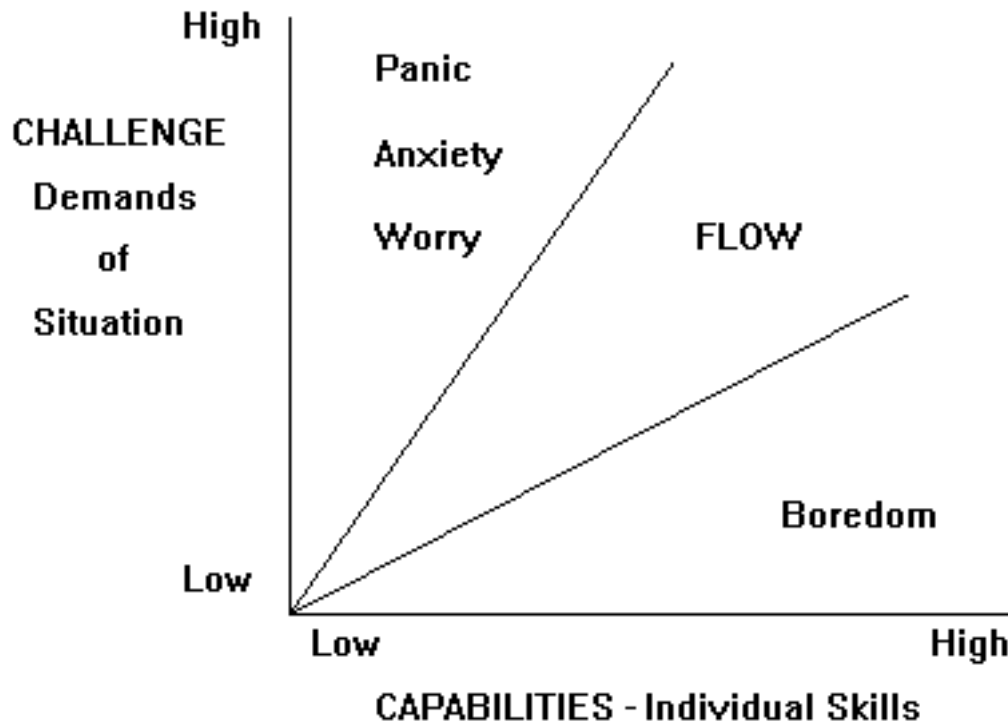


Figure 6²⁰: A diagram of a flow experience. The two theoretically most important dimensions of the experience, challenges and skills, are represented on the two axes of the diagram. (Csikszentmihaly 1991)

These goals are also valid for the design of responsive spaces that provide room for affective dynamics. Csikszentmihaly sees the main challenge in balancing two dimensions of experience, boredom and anxiety, which he considers the most important ones. One has reached the flow state when one is neither experiencing boredom nor anxiety. The flow state can be intentional and unintentional. Thrill seekers like extreme mountain climbers for example, who derive pleasure from being in extreme conditions, will take into account great risks to intentionally reach a state of flow. On the

²⁰ <http://divcom.otago.ac.nz/tourism/research/electronicpubs/mountainmadness/gfx/graph1.gif> [04/03/04]

other hand flow can also be integrated into a culture so that everyday chores become close to flow activities. An example which (Csikszentmihaly 1991) cites is the life in some of the Alpine villages in the high mountain valleys of Europe. When a participant of a study in one of this villages was interviewed and asked what she enjoys doing most in life, she answered milking the cows, pruning the orchard... It is the activities that she has to do every day for her living which she enjoys the most. (Csikszentmihaly 1991)

There are two other states on which (Csikszentmihaly 1991) focuses, boredom and anxiety. Boredom arises from performing activities with which one is overly familiar and which have become too simple to provide a real challenge. Anxiety is the state in which one is overwhelmed by the complexity of an activity.

Applied to the design of responsive spaces, this means that one has to balance the complexity of the space with the affordances of the space that allow the player to learn how to interact with the space and with other players and to gain mastery. When the player has mastered a certain aspect in the space or has improved his skills sufficiently to reach a state of enjoyment or flow, the space should allow further possibilities of improving and refining one's activities to sustain the engagement of the player and to prevent him from entering the dimension of boredom.

One of the limitations of Csikszentmihaly's theory is that it only works with two dimensions, between which the player can move. Scenarios with three poles or one pole are not included. One could think of a scenario that uses

four dimensions like rage, anxiety, lust and despair and in which the state of the player can continuously move within those poles. Using the state engine of the TGarden system, dynamical state topologies that allow the state of the system and of the players to move continuously between any number of states can be created. (Sha, MacIntyre et al. 2004)

3.1.3 Affect Design

Slowly, the importance of affect and emotion is being recognized in the field of human computer interaction. Affect is seen as a crucial element in the design of interactive systems. Whereas MIT's affective computing group²¹ is focusing mainly on "recognizing patterns of affective expression"²², "modeling affective experience"²³ and "synthesizing emotions in machines"²⁴ I want to look at the design heuristics for responsive spaces for affective dynamics.

Even Donald A. Norman, who solely focused on usability and efficiency in his earlier works like (Norman 1998) and was thus criticized by many designers for advocating a design approach that would lead to usable but ugly designs, has changed his view. His latest book is even titled "Emotional Design" (Norman 2004). In a recent talk at Georgia Tech he discussed how

²¹ <http://affect.media.mit.edu/> [04/08/04]

²² see above

²³ see above

²⁴ see above

one could make a choice between two interfaces for the same task. He went on to explain that one could use HCI methodology and do a study about the issue to see which of the two interfaces would be more efficient to use, only to dismiss this idea right away with the words that “we all know that doesn’t matter”. He then stated that the interface that is more pleasurable to use would be the preferred one.

The theory about affect developed by Norman in his paper “The role of affect and proto-affect in effective functioning.”, which he reiterates in (Norman 2004) , provides a foundation for the development of strategies for effective affective design. He suggests that there are three levels of processing in the brain, visceral, behavioral and reflective, and that design can be geared to appeal to either one of these levels.

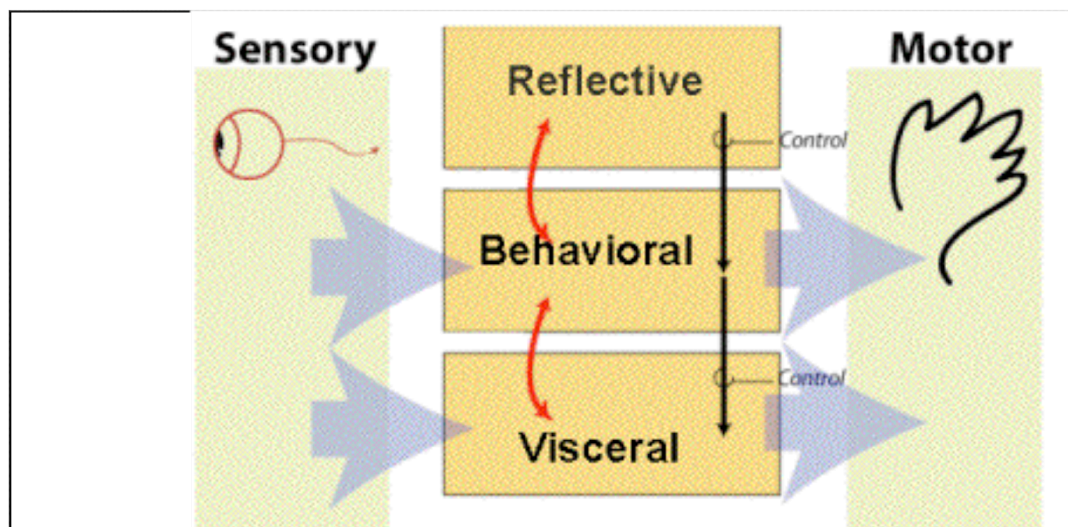


Figure 7: Three levels of processing: Visceral, Behavioral and Reflective.
(Norman 2004)

The visceral level is fast, makes rapid judgments and sends appropriate signals to the muscles and alerts the rest of the brain, and Norman sees this as the start of affective processing. As the name suggests, the behavioral level controls human behavior. It is influenced by the reflective layer, which is the seat of consciousness and feelings like guilt, pride and shame.

The layer that is most important for a better understanding of the development for responsive spaces for affective dynamics is the visceral layer. By understanding how sensory information can give rise to positive and negative affect a set of conditions can be formulated. These can serve as design criteria or affordances for responsive spaces that strive to be effective on this level. Norman list several conditions for positive affect (Norman 2004), including:

- Warm, comfortably lit places
- Temperate climate
- Sweet tastes and smells
- Bright, highly saturated hues
- "soothing" sounds and simple melodies and rhythms
- harmonious music and sounds
- caresses
- smiling faces

- rhythmic beats
- “attractive” people
- symmetrical objects
- rounded, smooth objects
- “sensuous” feelings, sounds, and shapes

According to (Norman 2004), automatic negative affect is produced by the following conditions:

- heights
- sudden unexpected loud sounds or bright lights
- “looming” objects (objects that appear to be about to hit the observer)
- extreme hot or cold
- darkness
- extremely bright light or loud sounds
- empty, flat terrain (deserts)
- crowded dense terrain (jungles or forests)
- crowds of people

- rotting smells, decaying foods
- bitter tastes
- sharp objects
- harsh, abrupt sounds
- grating and discordant sounds
- misshapen human bodies
- snakes and spiders
- human feces (and its smell)
- other people's body fluids
- vomit

Some of these conditions are not applicable to the design of responsive spaces. Unless the designer feels a close affiliation to Viennese actionism and wants to include his or others bodily fluids in the design to create a certain affective response, the last conditions on the list for negative affect are of limited usefulness. Generally speaking, it would be easy to dismiss Norman's conditions as too simplistic, leading the designer to believe that they could be used like a cook book for design; if you want more negative affect, just add some snakes and spiders. This view would trivialize the de-

sign and reduce the role of the designer to someone who merely picks the right effects to create the desired affect.

On the other hand, it is useful to know the affective connotations of certain conditions. When programming responsive video in Jitter, for example, one should be aware of that the use of symmetrical, rounded and smooth objects is likely to create some kind of positive affective reaction and the use of extremely bright light or sharp objects that seem to be about to hit the player will create rather negative affect. The same is true for the sound design. For example, Harsh, abrupt sounds, grating and discordant sounds are contrasting harmonious sounds and rhythmic beats in the kind of affect they produce.

Norman's theory of affect provides a view of the phenomenon that does not take context into account. For example he cites heights as a condition for negative affect. This might be true for someone suffering from acrophobia (fear of heights) but for other people like the mountain climbers (Csikszentmihaly 1991) describes, being in high places can be a condition for an optimal or flow experience and definitely does not produce a negative affective response in them. His analysis is also extremely binary because it separates affective states into only two categories, positive versus negative.

Brian Massumi looks at movement, affect and sensation from a humanistic point of view. In his book *Parables for the Virtual*, Massumi examines the body and media like film, television and the internet and also the body and ubiquitous computing. He draws from scientific and cultural theory to de-

scribe the relationship between movement, affect and sensation. Whereas Norman is able to provide some limited guidelines for affective design, Massumi's argument can be also applied to understand affect and emotion in responsive spaces. His ideas resonate with my previous experience in choreography of topological media.

Massumi defines two main aspects that define the body: movement and sensation, which are intrinsically connected (Massumi 2002). The connection of sensation and movement is also one of the main differences between responsive spaces and other forms of (digital) media, like computer games or television, where a forced separation of these two aspects takes place. Massumi then points out that sensation is always self-referential ("the feeling of having a feeling"). One should think of sensation as a resonance, or interference pattern. He gives an echo as example, and compares it to the body, where the walls are the sensory surfaces. Distance is converted into intensity through resonance. There is immediate self-relation, without a subject, but the conditions of emergence of a subject may be there. Massumi speaks of a "self-" (Massumi, 14)

Massumi goes on to state that he will equate intensity with affect (Massumi 2002), which makes the variation of intensity an important criterion for the design of responsive spaces for affective dynamics.

He also says that "there seems to be a growing feeling within media, literary, and art theory that affect is central to an understanding of our information- and image-based late capitalist culture, in which so-called master

narratives are perceived to have foundered.” (Massumi 2002) (see also (Gendlin 1997)). “The problem is that there is no cultural-theoretical vocabulary specific to affect. (Massumi, 27)”.

Spinoza defines affect as an “affection [in other words impingement upon] the body, and at the same time the idea of the affection”. Thus, the idea of the affection is doubled by an idea of the idea of the affection (Massumi, 31). (Massumi, 33) goes on to state that “Affect is their [mind/body, volition/cognition, expectation/suspense, action/reaction ...] point of emergence, in their actual specificity, and is their vanishing point, in singularity, in their virtual coexistence and interconnection.”

The degree of autonomy that affect has depends on the extent in which it has escaped from the “body whose vitality or potential for interaction, it is. (Massumi, 35)” The autonomy of actually existing, structured things which live in and through that which escapes them is the autonomy of affect. One’s own vitality, the sense being alive one has is perceived in this affective escape. (Massumi 2002)

(Massumi 2002) emphasizes the absence of a clear line of demarcation between the physical, the vital (for example the jellyfish being its own brain), the human and the superhuman. This resonates with (Csikszentmihaly 1991), who points out the problems that have arisen with the emergence of the individual self and sees the integration and reunion with other entities without losing one’s hard-won individuality as a way to resolve the problem of meaning.

(Massumi 2002) defines proprioception, declaring that “the memory it constitutes could be diagrammed as a superposition of vectorial fields composed of multiple points in varying relations of movement and rest, pressure and resistance, each field corresponding to an action.” This constitutes a dimension of the flesh. (Massumi 2002) His idea of vectorial fields resonate with the field theory developed by Maxwell and later Einstein, which includes the idea of the potential. The concept of a mathematical field is integrated in the dynamics engine of the TGarden framework, which is used to simulate the physics of the room and calculate the states of the room and the players, making it a fundamental part of the choreography of a responsive space.

3.1.4 Driving the action

Some interactive environments include more than one scene²⁵ or multiple levels²⁶. Each of these scenes can have different modes of interaction with the system and /or between players. Different scenes can also consist of different sound and video elements; they can have a different tone.

There are several possible ways the transition from one scene to another can be controlled. One possibility would be a timer that starts when a user enters the space and that prompts the system to switch to the next scene

²⁵ scene is used in analogy to its use in theatre

²⁶ borrowing this term from computer games, where a level can be one of many parts, stages or scenes of a particular game

after a fixed amount of time has passed. In this case, the system is driving the action forward.

Another possibility would be measuring for example the energy the user has created by his movements. When a certain threshold is reached, the system will start the next level. Here, the behavior of the user combined with an algorithm implemented in the system drive the action.

The third possibility is to create a gate or a portal that leads to the next scene. Applications like EyeCôn, that include scene management features, allow the designer to define a gate in a scene. When the player walks through the gate, he enters the next scene. The user is in complete control of driving the action forward.

The fourth area is using the dynamical media choreography engine which is part of the TGarden code base. Instead of using a narrative strategy in which the player can move from one scene to the next, the designer can create several states. The state of the responsive space can move continuously between these states. Changes in the state of the room can be expressed with changes in sound and video and the behavior of the room, i.e. how it responds to the player's actions.

3.2 Evaluation

The creation of responsive spaces is interdisciplinary in nature and draws from a broad range of disciplines. These fields include among others theater, human computer interaction, film, topology and performance art. To evaluate such a space using only the methods and criteria from one of these disciplines would limit the scope of the evaluation and lead to a too narrow view of the responsive space. Thus, a thorough evaluation should be based on methods taken from a variety of fields and should expand on them to find criteria that are specific for the evaluation of responsive spaces. An analogy of how we could measure and evaluate responsive spaces could be taken from existing practices in fields like theater, film and dance. How do we measure film and dance? We write reviews, ask peers about their experience and of course take into account our own experience.

The criteria provided by (Bordwell and Thompson 2001) for the evaluation of films can be adapted to also be useful for a non-narrative form like responsive spaces. The first criterion proposed by them is coherence. Regarding responsive spaces, coherence allows the player to become fully immersed in the responsive space. She is not distracted by elements of the space that seem not to fit and disturb her experience. Also, the interactions with the space need to be coherent in order to be understood and learned by the user. One example for coherence in the design of a part of an interactive performance is the scene "Handke" in Riviera. Whenever the performer picks up one of the several pieces of paper that are scattered all

over the floor, he triggers a sound sample by Peter Handke. The playback speed of the sample is determined by how fast the piece of paper is picked up. The interaction is still coherent, since the pattern of the interaction – gesture triggers sound – is clear and consistent throughout the scene.

Another criterion proposed by (Bordwell and Thompson 2001) is intensity of effect . Specifically they ask if an artwork is vivid, striking, and emotionally engaging. To evaluate a responsive space designed for affective dynamics, this criterion is a useful starting point. It needs to be expanded to include not only effect, but also the affective and emotional response in the player. Questions that can be asked are if there is the possibility of catharsis in the space being evaluated or if there can be pathos in this space.

Complexity, which is suggested next by (Bordwell and Thompson 2001) is important for an interactive experience to remain engaging and interesting also after extended play. (Bordwell and Thompson 2001) state that “a complex film engages our perception on many levels, creates a multiplicity of relations among many separate formal elements, and tends to create interesting formal patterns” and the same can be said about a complex responsive space. It is also important to note that complex does not mean complicated. A complex responsive space should not be complicated to understand and to use for the players.

3.3 Systems and Programming Paradigms

Research in the field of interfaces for embodied interaction has been going on for several decades and has brought forward a wide variety of results. A designer of responsive media spaces has to be aware that he has a whole range of options for creating responsive media spaces. In this chapter I want to provide an overview of several of the different software/hardware options and the underlying programming paradigms. What are the different programming paradigms used and when are they applied most effectively? The focus is especially on using *EyeCôn* and Max/MSP/Jitter as examples of different approaches. The reason for this choice is that I have extensive experience in creating responsive spaces and interactive performances with both systems.

3.3.1 Overview

Early systems that go back to the pioneering work of Ivan Sutherland in the 1960's typically include a "head mounted three dimensional display" (Sutherland 1968) and a data glove. Optionally these systems can include other units that are mounted on the body and connected by cables with the computer in order to help the user to navigate virtual spaces. Due to the constraints imposed by the wires, the player is not able to move in complete freedom. The player could not become immersed in the responsive space, since he is always limited by the cables. There is also the risk that a player or multiple players could become entangled in the cables. Due to these re-

strictions, the usefulness of this system for the creation of responsive spaces is very limited.

A newer system, which meets the requirement of allowing the players to move freely and unwired is the *Martin Lighting Director*²⁷. This motion-tracking system is produced by the Danish company *Martin* and provides a combined software- and hardware solution. The main use of this system is in the area of stage technology. I learned about this system from one of my teachers at the University of Karlstad, Sweden, the Canadian media artist Steve Gibson. He primarily uses the *Lighting Director* to generate music based on movement and gestures in different spaces. In his recent work *telebody*²⁸, the players have real-time control over not only an audio environment, but also images of two entire bodies.

The *Martin Lighting Director* utilizes small sensors that are attached to the torso and to the extremities of the player. These sensors have a wireless connection to the computer, where the data is being processed. The system can calculate the absolute position of the player in the space as well as the relative positions of her arms and her legs. The system is MIDI²⁹ based, which allows connecting other MIDI enabled devices like synthesizers, other computers for the generation of video and sounds or lighting controllers. The *MLD* software is used to attach actions to certain condi-

²⁷<http://www.martin.com/product/product.asp?product=lightingdirector> [03/24/04]

²⁸ <http://www.telebody.ws> [4.05.01]

²⁹ musical instrument digital interface, a standard protocol for communication between electronic musical instruments and computers (<http://dictionary.reference.com/search?q=musical%20instrument%20digital%20interface> [04/02/04])

tions or events. For example, one can specify that if the player's location is xyz a certain sample is triggered. The advantage of this system over camera-based tracking solutions is the precision with which the sensors track the position of the player. Lighting, contrast and other optical factors have no influence on the accuracy. On the other hand, a camera based tracking system does not require any sensors to be worn on the body. Another consideration is that the *MLC* is a professional stage system and thus rather pricy.

There are several camera-based motion tracking systems, which are based on computer vision techniques that are used to analyze a video signal that can come from one or more video cameras. Noteworthy systems are David Rokeby's *soft Very Nervous System*³⁰, *BigEye*³¹ which was developed by *Steim* in the Netherlands and *EyeCôn*³² by the German – American performance group *Palindrome*. These applications have in common that they all are compatible with *Max*, which was developed by IRCAM. Now the development of *Max/MSP/Jitter* takes place at *Cycling74*³³. For *softVNS* the use of *Max* is a prerequisite, whereas *EyeCôn* and *BigEye* are stand alone applications that can be also used without *Max*.

³⁰ <http://www.interlog.com/~drokeby/softVNS.html> [02/22/04]

³¹ <http://www.steim.nl> [02/24/04]

³² <http://www.palindrome.de> [03/03/04]

³³ <http://www.cycling74.com> [03/03/04]

3.3.2 EyeCôn

The underlying principle of *EyeCôn* is rather simple. By using the *background* function, a snapshot of the current camera image is taken. All other images, which are received at a fixed frame rate³⁴ through the frame grabber card, are compared with the background image and examined for changes. These changes can be caused by the performer or a player who has entered the space. Changes in the lighting or repositioning objects are also registered. Based on the intensity and the position of these changes the programmed reactions are triggered by the software. There are three underlying concepts of how the changes can be analyzed, *Dynamic Fields*, *Touchlines* und *Color tracking*. In addition to that the sensitivity of the program can be altered. The user can specify the size of the change needed to cause a reaction.

The function *Dynamic Fields* defines areas in the image and measures their dynamic, which is expressed in numerical values. The user can draw rectangular *fields* in *EyeCôn's* video window as in a drawing application. The dynamics of the motion that occurs within these fields and can be connected to the desired musical parameters. For example, by mapping the field parameters to volume, an intensive movement creates a louder sound than a more gentle movement.

³⁴ typically between 15 and 30 fps

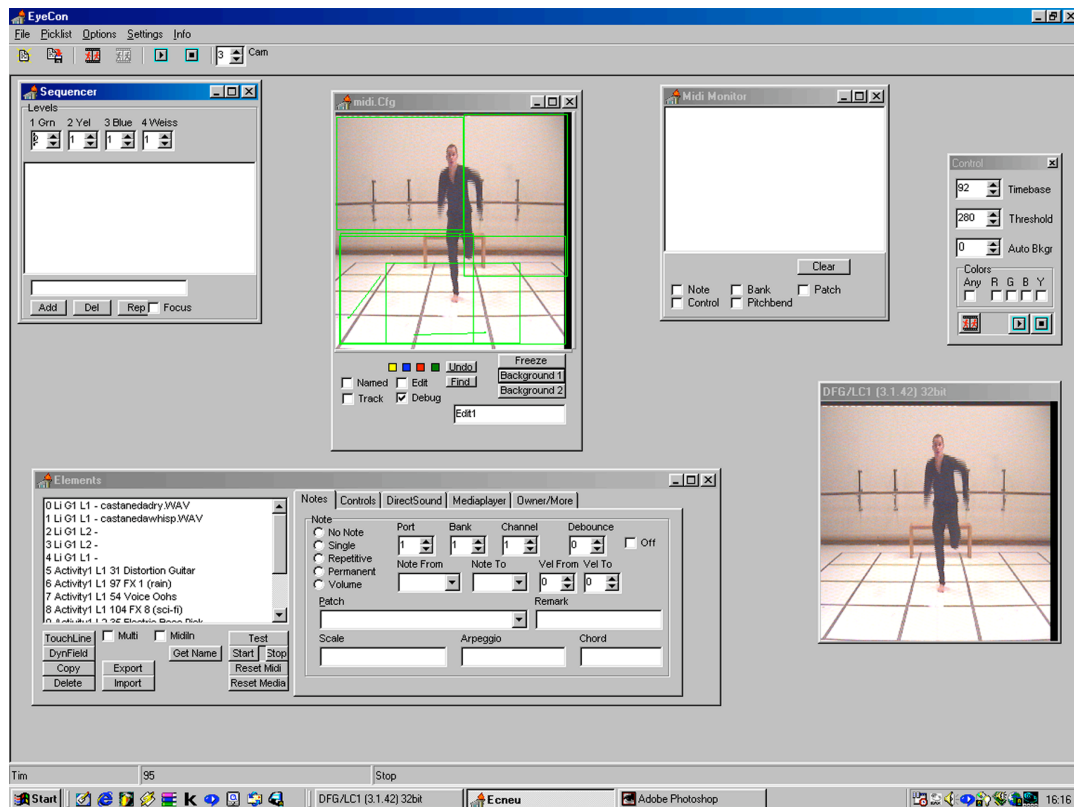


Figure 8: Screenshot of the *EyeCôn*-software. The performer is located in a space which has been separated with *Dynamic Fields*, which are represented by the green rectangles. The *Touch-line* located below the performer serves as a *Gate* for navigating to the next scene.

Touchlines allow programming a system of lines, which can trigger a variety of signals when being touched. An example of such a signal would be a MIDI message. As opposed to *fields*, which provide a more complex analytical tool, *touchlines* are used to find out if the line has been touched³⁵ or not. The *lines* can be used to trigger samples. More complex interactions

³⁵ touching the line means that the player is moving in the area of the responsive space or the stage where the line has been drawn. In the two dimensional representation on the screen it looks as if the player is actually “touching” the line.

programmed using a *line* could be changing the volume or the pitch by moving the hand up and down a *line*.

Color tracking can determine the position of colors in the video feed. The position can be determined absolutely (in relation to the filmed space) and also relatively (the distance between two colors). It is necessary to define the colors in advance and make sure that they don't occur anywhere else in the room, since this would interfere with the tracking.

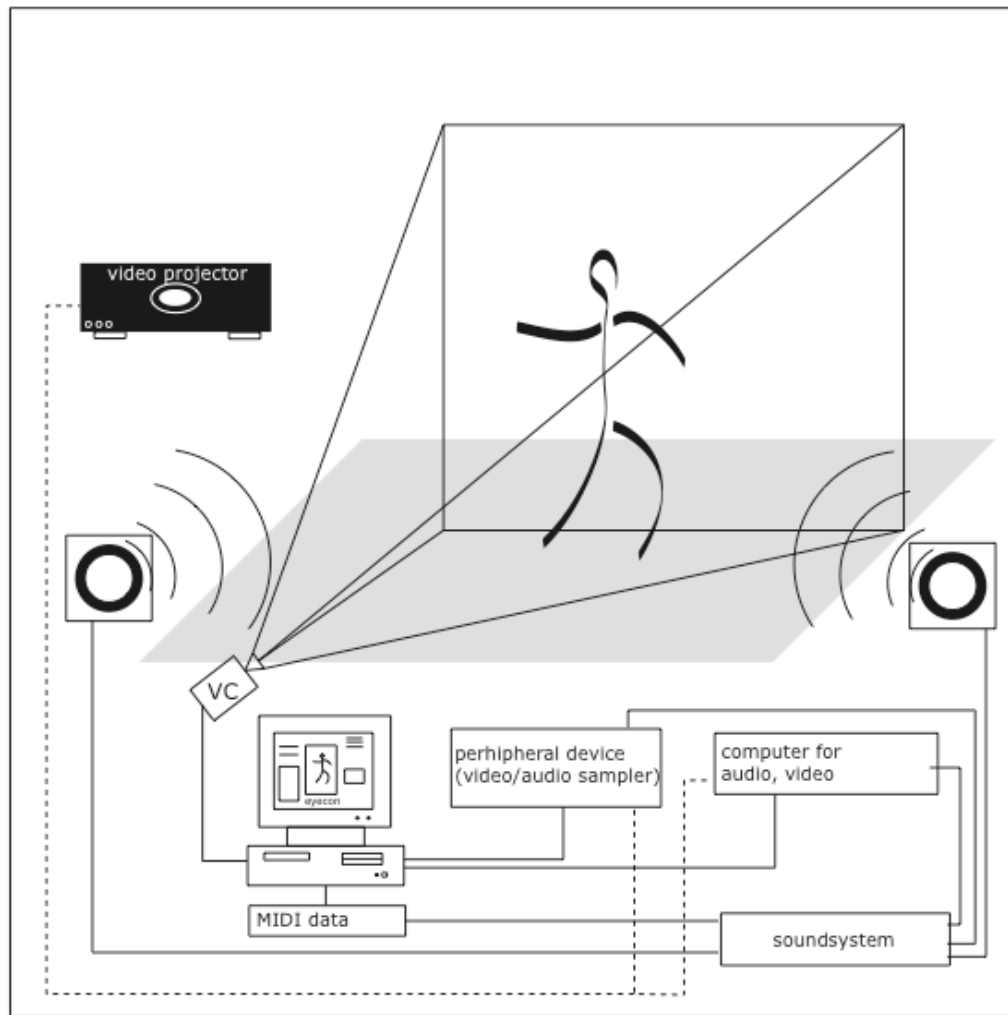


Figure 9: schematic diagram of an *EyeCôn* – system. The computer that runs *EyeCôn* sends MIDI data to other connected devices. To distribute the system load and reduce latency, real time video and audio are generated using a separate computer and a hardware sampler.

The variables that are generated by the aforementioned methods can be mapped to any musical parameter. The sound can be distorted, muted, pitched, amplified and more. *Fields* and *lines* can have multiple functions, they can be combined and overlap. One can have several structures in one

scene, *lines* and *fields* can create new fields, so that complex compositions in which the player can move freely are possible. *EyeCôn* also allows the creation of multiple levels or scenes. Changing the scene can either be controlled by an operator or by the player himself, using specialized *touch-lines* called *gates*. Attached to the *gate* is a method for branching, which is implemented in the form “if the line is triggered, switch to level x”. If the player moves through a gate, the scene is updated automatically and all the functions associated with this scene become active. This allows the player to explore a variety of different responsive spaces at his own pace. The change between different scenes works in real time.

3.3.3 Max/MSP/Jitter

Max/MSP/Jitter is the programming environment used for the creation of responsive media spaces by the Topological Media Lab, among them *Regina* and the *Membrane*, which are discussed earlier in this thesis. Max was developed at IRCAM³⁶, the Institut de Recherche et Coordination Acoustique/Musique in Paris in the mid-1980s by Miller Puckette. Since 1999 it has been published by Cycling '74³⁷, who also released a Windows version in addition to the original Mac version.

³⁶ <http://www.ircam.fr/>

³⁷ <http://www.cycling74.com>

Whereas Max/MSP is used mostly as an real time graphical programming environment for audio, Jitter, which is essentially a set of matrix data processing objects that extend Max/MSP, has the capability to create and process video in real time.

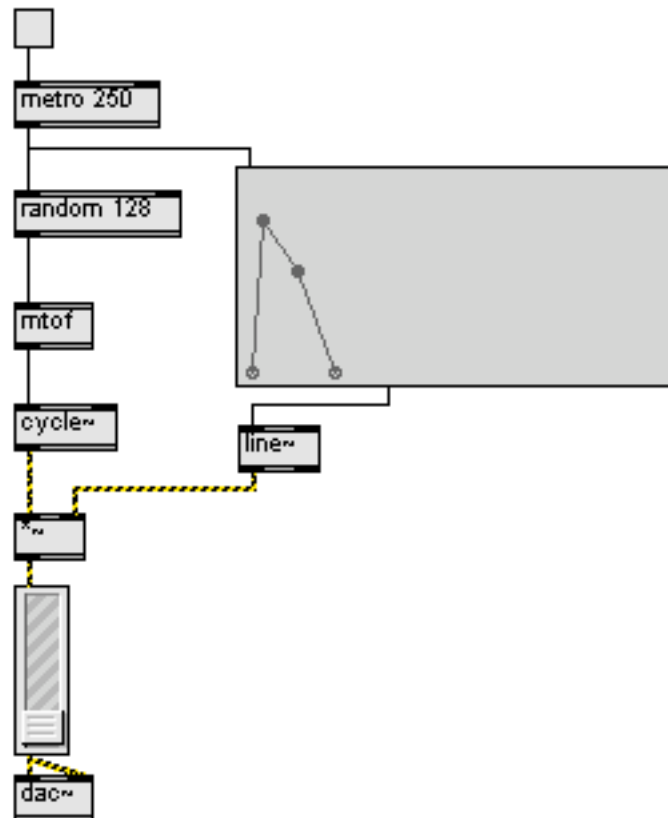


Figure 10: A simple Max patch³⁸

Max is a full programming language that is built on the metaphor of audio equipment that is connected with cords through which MIDI data flows. The

³⁸ http://www.cycling74.com/products/maxmsp_3.html [04/05/04]

but by combining and connecting the right objects and parameterizing them. After a raw version of a Max instrument is created this way it typically needs to be tuned. Tuning a video or audio instrument generated with Max/MSP/Jitter means adjusting it to resonate with a given space. For example, a video instrument might be adjusted to match certain lighting conditions or tuned to react only to intense movements of the player. This process can be performed by using Max' graphical interface and changing the necessary parameters which are connected to the inlets of specific Max objects.

Max patches can be combined with each other to form new patches, a way that larger and more complex responsive spaces can be organized. Once written, a patch can be reused in a different context. A library or repertoire of Max patches can be created, and like instruments they can be used to orchestrate different responsive spaces when combined and tuned in new ways.

In Max/MSP/Jitter, different forms of media can be processed. Audio data can be used to change a video image and vice versa, as in my piece *Prospero*, where a microphone picks up the breath of a player and Jitter is used to generate a video of a particle storm based on the signal analysis of the breath done in MSP. In connection with hardware like MakingThings' Teleo

kit³⁹ Max can also be used to build kinetic applications and make changes to the outside world.

4 Conclusion

Responsive media spaces can allow a fulfilling emotional interaction between the players. Embodiment, and involvement in the space, as opposed to mere spectatorship is an important step to achieving this goal. By creating environments that are as responsive and fine tuned as a music instrument and that allow the user to explore his own self in relation to the other users and the interactive system, a space that is providing rich affective dynamics can be created.

All the responsive spaces discussed in this thesis have transformative power on many different levels. In his reflections of his own work, David Rokeby has looked into this subject repeatedly. He summarizes his thoughts by saying: "Interfaces leave imprints on our perceptual systems which we carry out into the world. The more time we spend using an interface, the stronger this effect gets." (Rokeby 1998)

In my own work with responsive spaces, changes in affect and in perception was one of the phenomena I observed. The real and the virtual were

³⁹ <http://www.makingthings.com> [04/03/04]

blurred at the interfaces that were created for work like *Regina* or *Riviera*. One got lost in invisible soundscapes or tried to move real objects with the mouse.⁴⁰ Even after playing with the rich interactions in one of these responsive spaces and having left the room, some of the players still were under the persistent impression that their movements and gestures could control audio and video in their surroundings. Their bodies did not want to give up the agency they had inside the responsive space. The transformation, which took place on a corporeal level, was integrated into their perception and proprioception.

The affective dynamics of the responsive spaces that I discussed in this thesis consist of two main categories. Firstly, these spaces provide a pleasurable and emotionally fulfilling experience because they are a bridge between the imaginary/virtual and the actuality, between what (Massumi 2002) refers to as the "digital virtual" and the "analog actual". Through the movements that the players perform with their bodies they can conjure up images and sounds that previously only existed in the world of their imagination. One of the affective functions of these responsive spaces is that they give the players this transformative agency. The transformative agency in responsive media spaces comes from being able to manipulate, shape and sculpt media. This shaping of media works in the same way in which we are able to manipulate objects in the world, it is like a sculptor working with clay or painter with paint. This is a very different experience

⁴⁰ When I tried to move a bench on the stage, I tried to drag and drop it by clicking on it's representation on the screen. I even perceived the unwillingness of the bench to move when being manipulated in this way with a lack of understanding.

than the distance of theater. This distance still exists in *Riviera*, if the piece is seen from the point of view of the spectator and not from that of the performer. It also exists in video games and other forms of digital media but it does not exist in responsive spaces like *Regina* and *the Membrane* where there is no separation between audience and a performer and where the players are given transformative agency.

Secondly, some of the spaces reviewed, especially *Regina* and *the Membrane*, provide a room for the players to inhabit. In this spaces, they can engage in collective social and affective embodied play. Their interplay is based on common practice, on situatedness and on real time shared experience. Whereas in Myron Krueger's environments he still separates the players from their iconic representations, through which they can interact with objects and with each other, the other spaces discussed are based on embodied interaction, not on the separation of the body and its image. When Krueger describes that the players in *Videoplace* actually associated visual representation of their avatars touching each other with the sensation of touch, this is rather an accidental discovery than something that was considered when the environment was designed. My own responsive space *Regina*, which was created having this kind of affective dynamics in mind, does not need any avatars or representations. The interaction between the two players does not rely on a simulation of touch like *Videoplace* but on actual physical proximity of the players and real bodies touching each other. This is one of the most salient features that afford affective dynamics.

A media choreography system that can be used to build such a space has to fulfill several requirements. The system has to work in real time; responses to the player's actions have to be computed with only a very small amount of latency. If the latency is too high, the player does not have the sensation that the system responds to his actions anymore. It also has to be sufficiently robust to accommodate and respond to actions of the players that were unforeseen by the designer. In addition to that, the system has to be able to read and process different sources of information about the room and the players. These sources can be video motion tracking data and data from sensors worn on the body.

In short, physical proximity and physical co-presence, direct engagement and embodied interaction, having embodied agency and not using an avatar are crucial for the design of a responsive space for affective dynamics.

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